Appendix A

SAFETY GUIDELINES FOR DRILLING INTO SOIL AND ROCK AND HEALTH AND SAFETY PROCEDURES FOR ENTRY INTO BORINGS

A.1 SAFETY GUIDELINES FOR DRILLING INTO SOIL AND ROCK

A.1.1 Purpose

The purpose of this operating procedure is to provide guidelines for safe conduct of drilling operations with truck-mounted and other engine-powered drill rigs. The procedure addresses off-road movement of drill rigs, overhead and buried utilities, use of augers, rotary and core drilling, and other drilling operations and activities.

A.1.2 Application

The guidelines apply to projects in which truck-mounted or other engine-powered drill rigs are used. Normally for drill rigs operated by contractors, drill rig safety is the responsibility of the contractor.

A.1.3 Responsibility and Authority

Drill rig safety and maintenance is the responsibility of the drill rig operator.

A.1.4 Safety Guidelines

Movement of Drill Rigs

Before moving a rig, the operator must do the following:

1. As practical, inspect the planned route of travel for depressions, gullies, ruts, and other obstacles.

2. Check the brakes of the truck/carrier, especially if the terrain along the route of travel is rough or sloped.

3. Discharge all passengers before moving on rough or steep terrain.

4. Engage the front axle (on 4 x 4, 6 x 6, etc., vehicles) before traversing rough or steep terrain.

Driving drill rigs along the sides of hills or embankments should be avoided; however, if sidehill travel becomes necessary, the operator must conservatively evaluate the ability of the rig to remain upright while on the hill or embankment and take appropriate steps to ensure its stability.

Logs, ditches, road curbs, and other long and horizontal obstacles should be normally approached and driven over squarely, not at an angle.

When close lateral or overhead clearance is encountered, the driver of the rig should be guided by another person on the ground.

Loads on the drill rig and truck must be properly stored while the truck is moving, and the mast must be in the fully lowered position.

After the rig has been positioned to begin drilling, all brakes and/or locks must be set before drilling begins. If the rig is positioned on a steep grade and leveling of the ground is impossible or impractical, the wheel of the transport vehicle should be blocked and other means of preventing the rig from moving or tipping over should be employed.

A.1.5 Buried and Overhead Utilities

The location of overhead and buried utility lines must be determined before drilling begins, and their locations should be noted on boring plans or assignment sheets.

When overhead power lines are close, the drill rig mast should not be raised unless the distance between the rig and the nearest power line is at least 6 m, or other distance as required by local ordinances, whichever is greater. The drill rig operator or assistant should walk completely around the rig to make sure that proper distance exists.

When the drill rig is positioned near an overhead line, the rig operator should be aware that hoist lines and power lines can be moved towards each other by wind. Presence of power lines requires special safety provisions as they present serious danger

A.1.6 Clearing the Work Area

Before a drill rig is positioned to drill, the area should be cleared of removable obstacles and the rig should be leveled if sloped. The cleared/leveled area should be large enough to accommodate the rig and supplies.

A.1.7 Safe Use of Hand Tools

OSHA regulations regarding hand tools should be observed in addition to the guidelines provided below:

1. Each tool should be used only to perform tasks for which it was originally designed.

2. Damaged tools should be repaired before use or they should be discarded.

3. Safety goggles or glasses should be worn when using a hammer or chisel. Nearby coworkers and bystanders should be required to wear safety goggles or glasses also, or to move away.

4. Tools should be kept cleaned and stored in an orderly manner when not in use.

A.1.8 Safe Use of Wire Line Hoists, Wire Rope, and Hoisting Hardware

Safety rules described in 29 CFR 1926.552 and guidelines contained in the Wire RPE User's Manual, published by the American Iron and Steel Institute, will be used whenever wire line hoists, wire rope, or hoisting hardware are used.

A.1.9 Protective Gear

Minimum Protective Gear

Items listed below should be worn by all members of the drilling team while engaged in drilling activities:

- Hard hat
- Safety shoes (shoes or boots with steel toes and shanks)
- Gloves

Other Gear

Items listed below should be worn when conditions warrant their use. Some of the conditions are listed after each item.

- **Safety goggles or glasses** should be worn when: (1) driving pins in and out of drive chains, (2) replacing keys in tongs, (3) handling hazardous chemicals, (4) renewing or tightening gauge glasses, (5) breaking concrete, brick, or cast iron, (6) cleaning material with chemical solutions, (7) hammering or sledging on chisels, cold cuts, or bars, (8) cutting wire lines, (9) grinding on abrasive wheels, (10) handling materials in powered or semipowered form, (11) scraping metal surfaces, (12) sledging rock bits or core heads to tighten or loosen them, (13) hammering fittings and connections, and (14) driving and holding the rivets.

- **Safety belts and lifelines** should be worn by all persons working on top of an elevated derrick beam. The lifeline should be secured at a position that will allow a person to fall no more than 8 feet.

- **Life vests** must be used for work over water.

A.1.10 Traffic Safety

Drilling in streets, parking lots, or other areas of vehicular traffic requires definition of the work zones with cones, warning tape, etc., and compliance with local police requirements.

A.1.11 Fire Safety

1. Fire extinguishers should be kept on or near drill rigs for extinguishing small fires.

2. If methane is suspected in the area, a combustible gas instrument (CGI) shall be used to monitor the air near the borehole. All work should stop at 25 percent of the lower explosive limit.

3. Work shall stop during lightning storms.

A.2 HEALTH AND SAFETY PROCEDURES FOR ENTRY INTO BORINGS

A.2.1 Purpose

Down-hole geologic logging entails lowering a person into an uncased boring generally to gather information on the stratigraphy of the soil. Descent in some cases may exceed 30 m. The boring is a confined space, hence, hazards typical of confined spaces may be present. The major ones are oxygen deficiency, flammable concentrations of gases or vapors, toxic concentrations of gas or vapors, and wall collapse. Because visual inspection of the walls of the boring is essential to the logging process, the borings cannot be cased. These guidelines are prepared for down-hole logging operations, sound and uniform health and safety procedures that are in compliance with federal and state regulations.

These guidelines of the procedure are in full compliance with OSHA regulations contained in 29 CFR 1926.552, 29 CFR 1926,800 and incorporate more stringent regulations promulgated by Cal-OSHA and described in Section 1542, Subchapter 4, and Article 108, Subchapter 7, Division 4, Title 8 of the California Administrative Code (CAC). In all cases the local and state regulations regarding confined space entry and shaft entry must be reviewed and provisions more stringent than those contained in this operating procedure should be observed.

A.2.2 Applicability

This procedure applies to down-hole logging operations associated with geotechnical projects where toxic chemical releases are not known to have occurred. **The procedure may be used for downhole logging operations where toxic chemical releases have occurred, but only as an attachment to a site-specific health and safety plan that assesses the exposure risks associated with the logging operation and prescribes appropriate chemical-specific procedures for worker protection against the excessive exposure.**

A.2.3 Responsibility and Authority

The field supervisor and/or the geotechnical engineer have overall responsibility for safe conduct of the downhole logging operation and may not delegate that responsibility to another person.

A.2.4 Health and Safety Requirements

Permit Acquisition

Some states, such as California, require permits for construction of shafts to be entered by personnel and exceeding a certain depth (1.5 m in California). State and local government permit requirements shall be reviewed and complied with before any shaft is constructed.

Pre-entry Inspection

A qualified geotechnical specialist (engineer/geologist) shall be present a sufficient amount of time during the drilling process to thoroughly inspect and record the material and stability characteristics of the shaft and decide whether the walls of the shaft are stable enough so that it may be entered safely. Entry shall not be permitted if, in the specialist's opinion, the walls could collapse.

A qualified geotechnical specialist is an individual who has the following minimum qualifications:

1. Extensive hands-on experience in drilling and downhole geologic logging of uncased large-diameter borings so that the person is considered an expert by peers.

2. Experience in performing down-hole inspection or logging in the local area where work is being performed and/or experience in performing down-hole inspection/logging in other areas with similar geologic characteristics.

3. Prior training by other experienced geotechnical professionals.

4. Familiarity with the safe operation of the drilling and logging equipment being used, and the special difficulties, hazards, and mitigation techniques used in down-hole geologic logging.

Surface Casing and Proximity of Material to the Shaft Opening

The upper portion of the shaft shall be equipped with a surface ring-collar to provide casing support of the material within the upper 1.2 m or more of the shaft. The ring collar shall extend to 300 mm above the ground surface or as high as necessary to prevent drill cuttings and other loose material or objects from falling into or blocking access to the shaft. Drill cuttings, detached auger buckets, and other loose equipment must be placed far enough away from the shaft opening or secured in a fashion that would prevent them from falling into the shaft.

Gas Test

Prior to entry into a shaft, tests shall be performed to determine if the atmosphere in the shaft is not oxygen deficient and does not contain explosive or toxic levels of gases or vapors. Testing shall continue throughout the logging process to assure that dangerous atmospheric conditions do not develop. Monitoring instruments shall include a combustible gas meter and an oxygen meter. Where toxic gases or vapors may be present, a monitoring instrument equipped with a photoionization detector should be used for detection and quantification.

Ladders and Cable Descents

A ladder may be used to descend a shaft provided that the shaft is no deeper than 6 m. A mechanical hoisting device shall be used with shafts more than 6 m deep.

Hoists

Hoists may be powered or hand operated and must be worm geared or powered both ways. They must be designed so that when power is stopped, the load cannot move. Controls for powered hoists must be the deadman type with non-locking switch or control. A device for shutting off the power shall be installed ahead of the operating control. Hoist machines shall not have cast metal parts. Each hoist must be tested with twice the maximum load before being put into operation and annually thereafter. California regulations require a minimum safety factor of 6 for hoists. Test results shall be kept on file at the geotechnical engineer's office and other offices as required by the agency engaged in the geologic logging procedure. The hoist cable must have a diameter of at least 8 mm. Drill rigs may not be used to raise or lower personnel in shafts unless they meet the requirements in this section.

Cage

An enclosed covered metal cage shall be used to raise and lower persons in the shaft. The cage shall have a minimum safety factor of 4 and shall be load tested prior to use. The exterior of the cage shall be free of projections and sharp corners. Only closed shackles shall be used in cage rigging. The cage shall be certified by a registered mechanical engineer as having met all the design specifications. The certificate and load test results shall be kept on file.

Emergency Standby

In addition to the hoist or drill rig operator, an emergency standby person shall be positioned at the surface near the shaft whenever there is a geotechnical specialist in the shaft.

Communication

A two-way electrically-operated communication system shall be in operation between the standby person and the geotechnical specialist whenever the standby person and the geotechnical specialist is in a shaft that is over 6 m in depth or when the ambient noise level makes unamplified voice communication difficult. A cellular telephone at the drill rig is strongly recommended.

Safety Equipment

The geotechnical specialist must use the following safety equipment while in the shaft:

1. An approved safety harness designed to suspend a person upright. The harness must be attached to the hoist cable through a hole in the head guard. Attaching the harness to the head guard or cage is strictly prohibited.

2. Hardhat.

3. A steel cone-shaped or flat head guard or deflector with a minimum diameter of 450 mm must be attached to the hoist cable above the harness.

Electrical Devices

Electrical devices, such as lamps, combustible gas and toxic vapor detectors, and electric tools, must be approved for use in hazardous locations.

Surface Hazards

The storage and use of flammable or other dangerous chemicals at the surface must be controlled to prevent them from entering the shaft.

Water Hazard

The presence of water in the shaft must be determined before the shaft is entered. If the shaft contains more than 1.2 m of water, the level of water must be reduced to less than 1.2 m before entry is permitted. If a shaft is entered when water is present, the depth of the water must be measured periodically and the water level kept below 1.2 m if work is to continue.

Air Supply

NIOSH-approved supplied-air respirators (SCBA or airline) shall be available in the cage for use in the shaft when oxygen deficient atmosphere or toxic gases or vapors are encountered. If an airline system is used, the air pump or compressed air supply must be attended to by a person at the surface.

Illumination

Light intensity in the portion of the shaft being logged must be at least 3 m center-to-center. Lighting devices must be explosion-proof.

Work/Rest Periods

Time spent continuously in a shaft must not exceed two hours.

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Appendix B

GEOTECHNICAL EQUIPMENT SUPPLIERS
and
SERVICE TESTING COMPANIES

Soil Sampling, Drilling Rigs, Augering, & Rock Coring:

http://www.boartlongyear.com/subsanew/pages/prodserv.htm

http://www.christensenproducts.com/html/products.htm

http://www.cmeco.com/index.html

http://www.mobile-augers.com/

http://www.greggdrilling.com/

http://www.paddockdrilling.com/html/ct250.html

Continuous Soil Sampling Methods

http://www.ams-samplers.com/amsc1.html

http://www.geoprobesystems.com/66dtdesc.htm

Flat Plate Dilatometer Test (DMT) for soils:

General: http://webdisat.ing.univaq.it/labs/dmt/geodmt.html

Suppliers:

http://www.cambridge-insitu.com/DMT/Marchetti_Index.html

http://www.geotech.se/Dilatometer/dilatometer.html

http://www.gpe.org

http://www.pagani-geotechnical.com/english/dmt.htm

Cone Penetration Testing (CPT):

General:

The CPT Site at: http://www.liquefaction.com

Suppliers:

http://www.ara.com/division/arane/cpt/CPTList.htm

http://www.envi.se/

http://www.geomil.com/

http://www.geotech.se/

http://www.hogentogler.com

http://www.pagani-geotechnical.com/english/geotec2.htm

Service Companies:

http://www.conetec.com/

http://www.fugro.com/cpt.html

http://www.greggdrilling.com/INSitu.html

http://www.stratigraphics.com/

Pressuremeter Testing (PMT):

http://www.cambridge-insitu.com/

http://www.pagani-geotechnical.com/english/pressure.htm

http://www.roctest.com/roctelemac/product/product/boremac.html

Dilatometers for Testing Rocks:

http://www.cambridge-insitu.com/specs/Instruments/73HPDSPC.htm

Vane Shear Test (VST) or field vane (FV):

General: http://www.liquefaction.com/insitutests/vane/index.htm

http://www.apvdBerg.nl/products/16.htm

http://www.envi.se/products.htm

http://www.geonor.com/Soiltst.html

http://www.pagani-geotechnical.com/

Geophysical testing:

General Information:

http://www.geoforum.com/knowledge/texts/bodare/index.asp?Lang=Eng

http://www.matrixmm.com/geophysics_cd-rom.htm

http//talus.mines.edu/fs_home/tboyd/GP311/introgp.shtml

Suppliers of Equipment:

http://www.geometrics.com/products.html

http://www.geonics.com/products.html

http://www.geospacecorp.com/geophys.htm

http://www.oyo.com/Seismic/Products/das.htm

http://www.pagani-geotechnical.com/english/geophi.htm

http://www.sensoft.on.ca

Testing Companies:

http://www.agi.com

http://www.geovision.com

http://www.greggdrilling.com/methodology.html#sasw

http://olsoninstruments.com

Field Instrumentation Equipment

http://www.geocon.com

http://www.geokon.com/

http://www.rst-inst.com/

http://www.slopeindicator.com/

http://www.solinst.com/indexnet.html

Laboratory Testing Equipment Suppliers:

http://www.gcts.com/

http://www.geocon.com

http://www.geocomp.com/

http://www.gsc.state.tx.us/ecat/vendor/2198428045900.html

http://www.hmc-hsi.com/newest/hmc_catalog/Soil/soil.html

http://www.soiltest.com/

http://www.terratek.com/testequi.htm

Related books on In-Situ Testing available at:

http://www.guideme.com/Bookstores/INSITU.HTM

Related CDs & videos on In-Situ Methods:

http://www.geoinstitute.org/in-situ.html

Website Links to In-Situ Testing:

http://www.usucger.org